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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1

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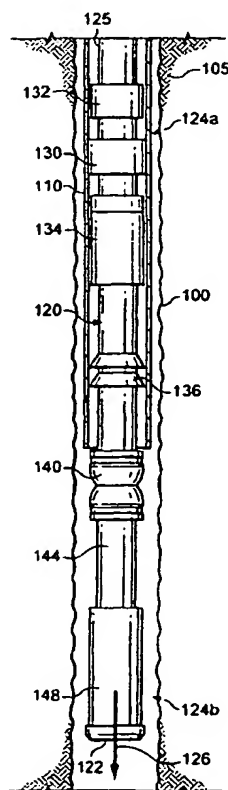
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(54) Title: MONO DIAMETER WELLBORE CASING



**(57) Abstract:** An apparatus (120) and system for radially expanding and plastically deforming an expandable tubular member (110) where the system comprises an anchoring mechanism (148) adapted to mate with an end of the expandable tubular member (110), a tubular member (125) releasably coupled to the anchoring mechanism (148), an adjustable expansion mandrel (140), and an actuator (134) coupled to the adjustable expansion mandrel (140) to controllably longitudinally displace the adjustable expansion mandrel (140) relative to the expandable tubular member (110). The expansion mandrel (140) is controllably expanded to a larger diameter for radial expansion of the expandable tubular mandrel (110) or collapsed to a smaller outside diameter.

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/14153

## A. CLASSIFICATION OF SUBJECT MATTER

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US CL : 166/384

According to International Patent Classification (IPC) or to both national classification and IPC

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Minimum documentation searched (classification system followed by classification symbols)

U.S. : 166/277,381,382,384,386,387,297,55,206,207,212,216,217,242.2

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
Please See Continuation Sheet

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,012,523 A (Campbell et al.) 11 January 2000 (11.01.2000), columns 3 and 4.	1-3,7-12
Y	US 4,848,459 A (Blackwell et al.) 18 July 1989 (18.07.1989), see Figure 1.	1-3,7-12
A	US 6,112,818 A (Campbell et al.) 05 September 2000 (05.09.2000), see Abstract.	1-12
A, P	US 6,425,444 B1 (Metcalf et al.) 30 July 2002 (30.07.2002), see Abstract.	1-12
A, P	US 6,631,765 B2 (Baugh et al.) 14 October 2003 (14.10.2003), see Abstract.	1-12
A	US 3,785,193 A (Kinley et al.) 15 January 1974 (15.01.1974), see Abstract.	1-12
A	US 6,021,850 A (Wood et al.) 08 February 2000 (08.02.2000), see Abstract.	1-12

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

\* Special categories of cited documents:

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document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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**INTERNATIONAL SEARCH REPORT**

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**Continuation of B. FIELDS SEARCHED Item 3:**

**EAST**

search terms: expand, anchor, packer, valve, groove, grip

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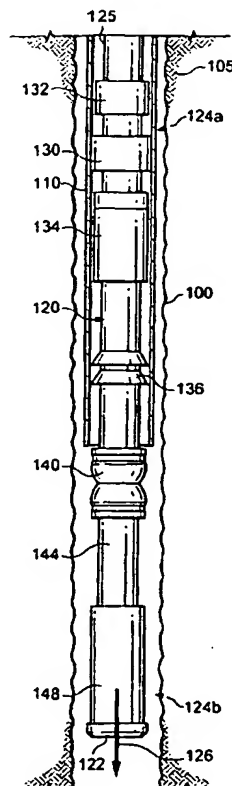
(74) Agents: MATTINGLY, Todd et al.; Haynes and Boone,  
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MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG,  
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forming an expandable tubular member (110) where the system comprises an anchoring  
mechanism (148) adapted to mate with an end of the expandable tubular member (110), a  
tubular member (125) releasably coupled to the anchoring mechanism (148), an adjustable  
expansion mandrel (140), and an actuator (134) coupled to the adjustable expansion man-  
drel (140) to controllably longitudinally displace the adjustable expansion mandrel (140)  
relative to the expandable tubular member (110). The expansion mandrel (140) is control-  
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(110) or collapsed to a smaller outside diameter.

WO 2003/093623 A3



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new claims 13-60 has been added (9 pages)]**

13. (New) An apparatus for radially expanding and plastically deforming an expandable tubular member, comprising:  
an anchoring mechanism adapted to mate with an end of the expandable tubular member;  
a tubular member releasably coupled to the anchoring mechanism,  
an adjustable expansion device coupled to the tubular member adapted to be controllably expanded to a larger outside dimension for radial expansion of the expandable tubular member or collapsed to a smaller outside dimension;  
an actuator coupled to the adjustable expansion device adapted to controllably longitudinally displace the adjustable expansion device relative to the expandable tubular member; and  
a gripping device coupled to the locking adapted to controllably engage the expandable tubular member.
14. (New) The apparatus of claim 13 further comprising a locking device coupled to the actuator adapted to controllably engage the expandable tubular member.
15. (New) The apparatus of claim 13 further comprising a sealing device for sealingly engaging the expandable tubular member adapted to define a pressure chamber above the adjustable expansion device during radial expansion of the expandable tubular member.
16. (New) The apparatus of claim 13 wherein the gripping device comprises:  
a tubular member having a plurality of tapered grooves defined on an exterior surface of the tubular member,  
a retaining sleeve coupled to the tubular member and adapted to slidably move longitudinally with respect to the tubular member, the retaining sleeve having a plurality of openings;  
a plurality of gripping elements positioned within the tapered grooves, wherein when the retaining sleeve is in a first longitudinal configuration, portions of the gripping elements protrude through the plurality of openings, and when the retaining sleeve is in a second longitudinal configuration, portions of the gripping elements do not protrude through plurality of tapered openings.
17. (New) The apparatus of claim 13 wherein the anchoring device is a float shoe, comprising:  
an expandable sleeve adapted to mate with the tubular member, wherein the tubular member is adapted to controllably expand the expandable sleeve to a larger outside dimension for radial expansion of the expandable sleeve to the expandable tubular member.
18. (New) The apparatus of claim 17 wherein the anchoring device comprises:  
a first passage,

a second passage,  
a seat within the first passage adapted to receive a plug,  
a sliding valve disposed within the first passage, adapted to direct flow from the first passage to the second passage, and  
a one-way valve coupled to the first and second passages.

19. (New) The apparatus of claim 13 wherein the anchoring mechanism is a packer.

20. (New) The apparatus of claim 13 wherein the packer is hydraulically actuated.

21. (New) The apparatus of claim 13 wherein the packer comprises:  
a first passage,  
a second passage,  
a first seat within the first passage adapted to receive a plug, and  
a sliding valve disposed within the first passage, adapted to direct flow from the first passage to the second passage.

22. (New) A method for radially expanding and plastically deforming an expandable tubular member within a borehole, comprising:  
positioning an adjustable expansion device, an anchoring device, and a coupling mechanism below the expandable tubular member such that the anchoring device contacts a bottom of the borehole,  
increasing the outside dimension of the adjustable expansion device; and  
displacing the adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member,  
displacing the anchoring device upwardly relative to the expandable tubular member such that the anchoring device contacts the bottom of the expandable tubular member,  
coupling the anchoring device to the bottom of the casing,  
uncoupling the adjustable expansion device from the anchoring device, and  
displacing the adjustable expansion device upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member.

23. (New) The method of claim 22, further comprising:  
lowering the adjustable expansion device to couple the expansion device to the anchoring device, and  
cementing the borehole, wherein the cementing flows through a flow path located in the anchoring device.



24. (New) The method of claim 22 further comprising expanding an expansion device coupled to the anchoring device such that the anchoring device couples to the casing.

25. (New) An apparatus for radially expanding and plastically deforming an expandable tubular member, comprising:

an anchoring mechanism adapted to mate with an end of the expandable tubular member;

a tubular member releasably coupled to the anchoring mechanism,

an expansion device coupled to the tubular member adapted to be controllably expanded to a larger outside dimension for radial expansion of the expandable tubular member or collapsed to a smaller outside dimension;

an actuator coupled to the adjustable expansion device adapted to controllably longitudinally displace the adjustable expansion device relative to the expandable tubular member; and

a gripping device coupled to the locking adapted to controllably engage the expandable tubular member.

26. (New) The apparatus of claim 25 further comprising a locking device coupled to the actuator adapted to controllably engage the expandable tubular member.

27. (New) The apparatus of claim 25 further comprising a sealing device for sealingly engaging the expandable tubular member adapted to define a pressure chamber proximate the expansion device during radial expansion of the expandable tubular member.

28. (New) The apparatus of claim 25 wherein the gripping device comprises:

a tubular member having a plurality of tapered grooves defined on an exterior surface of the tubular member,

a retaining sleeve coupled to the tubular member and adapted to slidingly move longitudinally with respect to the tubular member, the retaining sleeve having a plurality of openings,

a plurality of gripping elements positioned within the tapered grooves, wherein when the retaining sleeve is in a first longitudinal configuration, portions of the gripping elements protrude through the plurality of openings, and when the retaining sleeve is in a second longitudinal configuration, portions of the gripping elements do not protrude through plurality of tapered openings.

29. (New) The apparatus of claim 25 wherein the anchoring device is a float shoe, comprising:

an expandable sleeve adapted to mate with the tubular member, wherein the tubular member is adapted to controllably expand the expandable sleeve to a larger outside dimension for radial

expansion of the expandable sleeve to the expandable tubular member.

30. (New) The apparatus of claim 29 wherein the anchoring device comprises:
- a first passage,
  - a second passage,
  - a seat within the first passage adapted to receive a plug,
  - a sliding valve disposed within the first passage, adapted to direct flow from the first passage to the second passage, and
  - a one-way valve coupled to the first and second passages.
31. (New) The apparatus of claim 25 wherein the anchoring mechanism is a packer.
32. (New) The apparatus of claim 25 wherein the packer is hydraulically actuated.
33. (New) The apparatus of claim 25 wherein the packer comprises:
- a first passage,
  - a second passage,
  - a first seat within the first passage adapted to receive a plug, and
  - a sliding valve disposed within the first passage, adapted to direct flow from the first passage to the second passage.
34. (New) A method for radially expanding and plastically deforming an expandable tubular member within a borehole, comprising:
- positioning an expansion device, an anchoring device, and a coupling mechanism below the expandable tubular member;
  - displacing the expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member,
  - displacing the anchoring device upwardly relative to the expandable tubular member,
  - coupling the anchoring device to the bottom of the casing,
  - uncoupling the expansion device from the anchoring device, and
  - displacing the expansion device upwardly relative to the expandable tubular member  $n$  times to radially expand and plastically deform  $n$  portions of the expandable tubular member.
35. (New) The method of claim 34, further comprising:
- lowering the expansion device to couple the expansion device to the anchoring device, and
  - cementing the borehole, wherein the cementing flows through a flow path defined in the anchoring

device.

36. (New) The method of claim 34 further comprising expanding an expansion device coupled to the anchoring device such that the anchoring device couples to the casing.

37. (New) A gripping device for gripping a wellbore casing, comprising:  
a tubular member having a plurality of tapered grooves defined on an exterior surface of the tubular member,  
a retaining sleeve coupled to the tubular member and adapted to slidably move longitudinally with respect to the tubular member, the retaining sleeve having a plurality of openings,  
a plurality of gripping elements positioned within the tapered grooves, wherein when the retaining sleeve is in a first longitudinal configuration, portions of the gripping elements protrude through the plurality of openings, and when the retaining sleeve is in a second longitudinal configuration, portions of the gripping elements do not protrude through plurality of tapered openings.

38. (New) An anchoring device for anchoring the position of a wellbore casing, comprising:  
an expandable sleeve adapted to mate with the wellbore casing.

39. (New) An anchoring device for anchoring the position of a wellbore casing, comprising:  
a housing,  
a first passage defined within the housing,  
a second passage defined within the housing,  
a seat within the first passage adapted to receive a plug,  
a sliding valve disposed within the first passage, adapted to direct flow from the first passage to the second passage, and  
a one-way valve coupled to the first and second passages.

40. (New) A system for radially expanding and plastically deforming an expandable tubular member within a borehole, comprising:  
means for positioning an adjustable expansion mandrel, an anchoring device, and a coupling mechanism below the expandable tubular member such that the anchoring device contacts a bottom of the borehole,  
means for increasing the outside dimension of the adjustable expansion mandrel;  
means for displacing the adjustable expansion mandrel upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member,  
means for displacing the anchoring device upwardly relative to the expandable tubular member such

that the anchoring device contacts the bottom of the expandable tubular member,  
means for coupling the anchoring device to the bottom of the casing,  
means for uncoupling the expansion mandrel from the anchoring device, and  
means for displacing the adjustable expansion mandrel upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member.

41. (New) The system of claim 40, further comprising:

means for lowering the adjustable expansion mandrel to couple the expansion mandrel to the anchoring device, and  
means for cementing the borehole, wherein the cementing flows through a flow path located in the anchoring device.

42. (New) The system of claim 40 further comprising means for expanding an expansion device coupled to the anchoring device such that the anchoring device couples to the casing.

43. (New) A method for radially expanding and plastically deforming an expandable tubular member within a borehole, comprising:

means for positioning an adjustable expansion device, an anchoring device, and a coupling mechanism below the expandable tubular member such that the anchoring device contacts a bottom of the borehole,

means for increasing the outside dimension of the adjustable expansion device;  
means for displacing the adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member,  
means for displacing the anchoring device upwardly relative to the expandable tubular member such that the anchoring device contacts the bottom of the expandable tubular member,  
means for coupling the anchoring device to the bottom of the casing,  
means for uncoupling the adjustable expansion device from the anchoring device, and  
means for displacing the adjustable expansion device upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member.

44. (New) The system of claim 43, further comprising:

means for lowering the adjustable expansion device to couple the expansion device to the anchoring device, and  
means for cementing the borehole, wherein the cementing flows through a flow path located in the

anchoring device.

45. (New) The system of claim 43 further comprising means for expanding an expansion device coupled to the anchoring device such that the anchoring device couples to the casing.

46. (New) A system for radially expanding and plastically deforming an expandable tubular member within a borehole, comprising:

means for positioning an expansion device, an anchoring device, and a coupling mechanism below the expandable tubular member;  
means for displacing the expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member,  
means for displacing the anchoring device upwardly relative to the expandable tubular member,  
means for coupling the anchoring device to the bottom of the casing,  
means for uncoupling the expansion device from the anchoring device, and  
means for displacing the expansion device upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member.

47. (New) The system of claim 46, further comprising:

means for lowering the expansion device to couple the expansion device to the anchoring device, and  
means for cementing the borehole, wherein the cementing flows through a flow path defined in the anchoring device.

48. (New) The method of claim 46 further comprising means for expanding an expansion device coupled to the anchoring device such that the anchoring device couples to the casing.

49. (New) A method of gripping a wellbore casing, comprising:

gripping the interior surface of the wellbore casing at a plurality of discrete spaced apart locations.

50. (New) A method of anchoring the position of a wellbore casing, comprising:

radially expanding and plastically deforming a sleeve within the wellbore casing into contact with the interior surface of the wellbore casing.

51. (New) A system for gripping a wellbore casing, comprising:

means for gripping the interior surface of the wellbore casing at a plurality of discrete spaced apart locations; and  
means for actuating the means for gripping.

52. (New) A system for anchoring the position of a wellbore casing, comprising:  
means for radially expanding and plastically deforming a sleeve within the wellbore casing into contact with the interior surface of the wellbore casing; and  
means for controlling the means for radially expanding and plastically deforming the sleeve.
53. (New) A method of radially expanding and plastically deforming a tubular member, comprising:  
pressurizing an interior portion of the tubular member; and  
displacing an expansion device through the pressurized interior portion of the tubular member.
54. (New) The method of claim 53, wherein pressurizing an interior portion of the tubular member comprises pressurizing an annular interior portion of the tubular member.
55. (New) The method of claim 53, wherein displacing an expansion device through the pressurized interior portion of the tubular member comprises pulling the expansion device through the pressurized interior portion of the tubular member.
56. (New) The method of claim 53, wherein pulling the expansion device through the pressurized interior portion of the tubular member comprises using the operating pressure of the pressurized interior portion of the tubular member to pull the expansion device through the pressurized interior portion of the tubular member.
57. (New) A system for radially expanding and plastically deforming a tubular member, comprising:  
means for pressurizing an interior portion of the tubular member; and  
means for displacing an expansion device through the pressurized interior portion of the tubular member.
58. (New) The system of claim 57, wherein means for pressurizing an interior portion of the tubular member comprises means for pressurizing an annular interior portion of the tubular member.
59. (New) The system of claim 57, wherein means for displacing an expansion device through the pressurized interior portion of the tubular member comprises means for pulling the expansion device through the pressurized interior portion of the tubular member.

60. (New) The system of claim 57, wherein means for pulling the expansion device through the pressurized interior portion of the tubular member comprises means for using the operating pressure of the pressurized interior portion of the tubular member to pull the expansion device through the pressurized interior portion of the tubular member.